

Section 7: Action Plan

Since the Lake Huron Binational Partnership was formed in 2002, partner agencies have been aligning their programs and projects to address the priority issues that have been identified through this effort. A workplan for both short term and long term activities has been drafted and many of these critical activities are already underway.

7.1 Canadian Watershed

In order to address binational priorities as well as issues on the Canadian side of the Lake Huron basin, a federal/provincial working group was established in 2002. A number of needs are met by the working group such as information sharing, partnering on projects as well as workplanning and reporting under the requirements of the Canada Ontario Agreement (COA). A south east shore working group functions as a subcommittee to the federal/provincial group and focuses specifically on the bacteria and algae fouling issues at Lake Huron's beaches along the shore from Southampton to Sarnia.

7.1.1 Activities Addressing Contaminants in Fish and Wildlife

Canadian information on contaminants in fish and resulting sport fish consumption advisories have been assembled, synthesized and combined with U.S. information into a fact sheet for general distribution by the Lake Huron Binational Partnership. In addition, a report summarizing current status, trends and distributions of wildlife along the Canadian shores of Lake Huron has been prepared and covers populations, contaminant levels and habitat of colonial waterbirds, marsh birds, waterfowl, birds of prey, amphibians, reptiles and mammals which feed on aquatic life in Lake Huron and its tributaries. The contaminant information from this report was combined with available U.S. data and presented in a Lake Huron Binational Partnership fact sheet.

By evaluating the status and trends of fish and wildlife contaminant levels, both geographically and temporally, it is possible to identify contaminants of concern to Lake Huron and recommend further investigations into suspected source areas and follow up with remedial measures.

7.1.2 Activities to Increase Understanding of Ecosystem Change, Biodiversity and the Impact of Exotic Species

The following projects are geared towards developing a better understanding of changes in Lake Huron:

- Integrated assessment of the microbial food web
- Lake Whitefish Food Web Interactions
- Trends in the Benthic Macroinvertebrate Community
- Growth, Condition and Energy Density of Lake Whitefish

In Canada, the federal Department of Fisheries and Oceans and the provincial Ministry of Natural Resources are engaged in a number of activities to study the structure and function of Lake Huron's ecosystem. Since the arrival of zebra mussels in the late 1980's and the subsequent and ongoing accidental introductions of a range of species from invertebrates to fish, shifts are beginning to take place in how food is transferred within the system and how aquatic communities are responding. Lakes Erie and Ontario have been subject to even more dramatic changes because of their smaller size and shallower depths. The microbial food web is an important link at the bottom end of the food chain, particularly in the offshore areas where nutrients are low. A study of the offshore communities and a comparison with nearshore areas has been underway since 2003 under DFO's lead with Canadian and U.S. researchers.

Benthic macroinvertebrate community trends were measured in 2000 and 2003 with an emphasis on changes in abundance of the amphipod *Diporeia* and dreissenid mussels (zebra and quagga) by NOAA

with MNR and Environment Canada's NWRI participation. A study by MNR's Fish and Wildlife Branch to compare bioenergetics of Lake Whitefish growth before and after the invasion of zebra mussels and spiny water flea will assess food web interactions. Under NOAA's lead, in cooperation with Michigan's Department of Natural Resources, and the U.S. Fish and Wildlife Service, MNR is contributing to an examination of the diet, condition and growth of Lake Whitefish in various regions of the lake. These variables will be examined relative to abundances of *Diporeia*. The study will also compare whitefish in locations of Lake Huron with and without *diporeia* to determine the potential lakewide effects of declines of this benthic invertebrate.

7.1.3 Activities Addressing Fish and Wildlife Habitat/Populations

The following projects are underway to assess status and trends and take action on restoring and protecting habitat and populations in the Canadian portion of the Lake Huron basin:

- Summary report on wildlife populations and habitat
- Assessment and protection of fish habitat and populations in selected nearshore, coastal and spawning areas of Lake Huron
- Barriers to fish movement project
- Watershed rehabilitation and protection projects in the Ausable, Bayfield, Maitland, French and Manitou Rivers, Huronia Area tributaries and Blue Jay Creek.

A report entitled "Current Status, Trends and Distributions of Aquatic Wildlife along the Canadian Shores of Lake Huron" is in the final stages of preparation by Environment Canada and will assist in targeting high priority areas for protection and restoration in the watershed. Fish community and habitat assessments are underway in many areas of the lake by MNR's Lake Huron Unit and various district offices. A nearshore small fish community and exotic species assessment is being conducted lakewide and will evaluate the status of native populations with a comparison to populations of round goby. In Georgian Bay and the North Channel, walleye spawning habitat is being inventoried and assessed. The identification and GIS mapping of Lake Trout and Lake Whitefish spawning shoals and their assessment will aid in habitat protection and better stocking practices. Lake Sturgeon spawning locations are being identified to determine what rehabilitation efforts are needed and if current harvest levels are sustainable.

Various wetlands in coastal and river delta areas along the Canadian shore of Lake Huron are being measured for a broad set of physical, chemical and food-web characteristics by researchers from McMaster University in cooperation with MNR and EC. The work will lead to the development of biotic indicators of wetland health and relate to anthropogenic disturbances.

Satellite imagery and various other assessment techniques are being applied in important coastal wetlands (Central Algoma, Southern Lake Huron and Georgian Bay) under several projects which support the need for current and accurate information on which to base management decisions for habitat enhancement and protection. A project to identify and map barriers to fish movement in tributaries to Lake Huron in the Maitland, Nottawasaga and Severn Sound areas have contributed to a binational GIS project for Lake Huron and will assist in identifying areas where stream habitat can be improved through dam removal.

Projects underway by MNR's district offices are targeted to local watersheds in the Canadian side of the Lake Huron basin. These projects assist rural landowners in addressing sources of contaminants and erosion on their properties and encourage best management practices through river clean-up, plantings, establishing buffer strips, stream rehabilitation, managing nutrients and drainage. A key component of these projects is to inform, educate and influence sound stewardship practices on the landowner property which will result in improvements to water quality and fish habitat.

In addition, the Lake Huron Lake Committee under the Great Lakes Fishery Commission have a number of activities underway which support the goals of the Lake Huron Binational Partnership:

- Fish stocking
- Sea Lamprey control

- The Development of Environmental Objectives supporting Fish Community Objectives
- Commercial and sport fish assessment projects
- Lake Huron Stewardship Councils

The Great Lakes Fishery Commission and the Lake Huron Lake Committee and Technical Committee have an established binational forum and process for addressing issues, research needs and management actions required to protect and enhance the Lake Huron fish community. The Commission coordinates the Sea Lamprey Control Program for all of the Great Lakes and includes the use of lampricide, barriers to prevent spawning, traps to remove females, sterilizing males and research. Between seven and thirteen million fish a year are stocked by the Michigan Department of Natural Resources, the U.S. Fish and Wildlife Service and the Ontario Ministry of Natural Resources. Three to four million of these stocked fish are lake trout and walleye aimed specifically at rehabilitation efforts.

The development of Environmental Objectives will address the need for habitat protection and enhancement to meet the abundances and species makeup desired for the lake, while ongoing annual assessments of the commercial and recreational fisheries provide essential information for maintaining the sustainability of the resource. Two Stewardship councils are supported to assist MNR in making management decisions related to the fisheries of Lake Huron.

7.1.4 Activities Addressing Nutrient and Bacteria Issues

Projects underway or planned to focus on the bacterial contamination and algal fouling of beaches along the south-east shore of Lake Huron include:

- Water quality surveys at nearshore index/reference stations
- Lake Huron south-east shore project
- Best Management Practices Compliance promotion activities
- MOE/OMAF Science Committee

Seventeen Lake Huron/Georgian Bay monitoring stations in the Great Lakes-wide suite of index and reference stations were surveyed in 2002 and 2003 by the Ontario Ministry of Environment as part of their long-term monitoring program. This data allows for temporal and spatial comparisons for Lake Huron and throughout the Great Lakes and connecting channels. This information will be compiled and used for overall evaluations of status and trends of conventional parameters as well as contaminants in water, surficial and suspended sediment.

The federal/provincial south-east shore working group has a workplan for a number of monitoring and research projects which will continue over several years. Partners in the working group include Environment Canada's regional staff and National Water Research Institute, Ontario's Ministries of Environment, Agriculture and Food, Natural Resources. A background summary of water quality monitoring information, complaints and beach posting information was prepared by the Lake Huron Centre for Coastal Conservation for Environment Canada. Specific research projects are aimed at microbial source tracking, and the influence of tributaries, groundwater, swash zone, wildlife (specifically birds), algae and beach management practices on *E.coli* levels on beaches. A more focused short-term approach will be followed by the MOE/OMAF Science Committee to examine sources of bacterial pollution in Huron County focusing on areas of shoreline which have been posted on a regular basis in recent years due to levels of the indicator *E.Coli* in water.

The Nutrient Management Act, enacted in Ontario in June of 2002 is a comprehensive, province-wide approach to nutrient management designed to protect soil and water quality in Ontario's rural communities by establishing regulations which are being phased in over time. However, in the meantime, best management practices are being promoted in the agricultural community through various techniques by responsible agencies (OMAF, MNR, Environment Canada and Conservation Authorities). Many of the

province's top watersheds that have experienced the greatest impact from livestock operations are in the Lake Huron basin (Blackie and Tuininga, 2003).

7.1.5 Activities at Areas of Concern

7.1.5.1 Spanish Harbour

The following activities are in support of tracking the recovery and ensuring ongoing management of the AOC:

- Spanish River Delta Fish Community Assessment
- Whalesback Channel Integrated Management Plan Initiative
- Spanish Harbour Restoration of Muskellunge Population
- Sediment and Benthos Assessment

Fish community assessments by MNR's district office in Espanola will gather and collate a database of existing fisheries data and measure the progress of fish community recovery. In addition, MNR will work with First Nations and stakeholders in the development of a comprehensive integrated management plan for species of recreational, commercial, and priority aboriginal food fishing interest in the Whalesback Channel. The muskie re-introduction work which has been ongoing for a number of years within the AOC will be evaluated now that the project has reached completion.

The National Water Research Institute (EC) conducted detailed sediment and benthic assessments in the AOC in 2003. The results of this work will be combined with recent data collected by MOE and used to assess the progress of natural recovery of contaminated sediment. A modeling exercise will assist in making predictions about when the AOC will have met the goals and can be delisted.

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7.1.5.2 Severn Sound

As a condition of delisting, MNR is completing (in 2004) a detailed analysis of the Severn Sound fish community, with emphasis on the walleye population and with assessments of small fish and exotic species. The Severn Sound Environmental Association also plans to meet the final delisting commitment in 2004 through a project to ensure the recognition and implementation of Fish Habitat Management Plans by its member municipalities and their inclusion in official plans.

7.2 U.S. Watershed

Over the past two years, Federal, State, Tribal, and local agencies have made considerable progress toward protecting and restoring the Lake Huron watershed. Persistent, bioaccumulating chemicals have been removed from the environment, populations of native species show signs of recovery, and communities are actively managing land-use to protect natural resources. Several highlights from major projects are provided below.

7.2.1 Addressing Contaminated Sediments in Areas of Concern

Some harbors and rivers within the Lake Huron watershed continue to be contaminated by the legacy of industrial pollution. Several programs target contaminated sediments for removal, before the sediments are dispersed by storm or flood events. The recently-passed Great Lakes Legacy Act (Public Law No: 107-303) may help advance ongoing efforts. The act authorizes appropriations up to \$50M per year from FY2004 through FY2008 to address contaminated sediment projects in Great Lakes Areas of Concern.

7.2.1.1 Saginaw Bay

Following the removal of about 345,000 cubic yards of contaminated sediments from five areas in the lower Saginaw River, Michigan Department of Environmental Quality and the U.S. Fish & Wildlife Service

continue to implement post-dredging activities and monitor ecosystem recovery. These activities are pursuant to a 1998 \$28.2 million natural resources damages settlement [under Superfund].

Michigan Department of Environmental Quality and U.S. EPA – Great Lakes National Program Office are performing surveys of the horizontal and vertical distribution of dioxin/furan concentrations in the Tittabawassee, Saginaw, Cass, and Shiawassee Rivers. While PCB contamination has been well documented in this area, dioxins and furans have not. This project is funded through U.S. EPA- GLNPO's competitive grant program and has received strong support from the U.S. Fish and Wildlife Services, as it will complement USFWS ecological risk assessment for dioxin like compounds in this watershed. The Service plans to ultimately use these study results to calculate congener-specific sediment to biota accumulation factors. The assessment is expected to be completed by 2005. Meanwhile, MDEQ has completed an aquatic ecological risk assessment for the Tittabawassee River and is working with Dow Chemical (under RCRA) to implement interim actions to protect human health while they develop plans for corrective actions to address the dioxin and dibenzofuran contamination in the Tittabawassee River and its floodplain.

Michigan Department of Environmental Quality and U.S. EPA Region 5 are continuing the DDT/PBB Pine River sediment cleanup and post-evaluation. This effort is funded through the Clean Michigan Initiative and Superfund. Total project cost to date is \$53 million. To date, about 400,000 cubic yards of DDT contaminated sediment has been removed (which includes approximately 750,000 lbs. of DDT). About 280,000 cubic yards remain. The clean-up to be completed by the end of 2007.

7.2.1.2 St. Marys River

U.S. EPA - GLNPO and Lake Superior State University is investigating possible downstream contamination of sediments at two focus areas with St. Marys River: the Little Rapids area, a candidate for restoration of open rapid habitat, and Munuscong Lake in the lower St. Mary's, which has undergone substantial hydrological manipulations in the past. This project was funded through U.S. EPA – GLNPO's competitive grant program. The assessment is expected to be completed in 2004.

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7.2.2 Partners in the Restoration of the Lake Huron Fishery

Federal, State, and Tribal agencies, in partnership with their Canadian counterparts, manage the open water fishery for the public. Several focused efforts are helping restore native species and maintain the sustainable productivity of the open waters.

7.2.2.1 Lake Trout Rehabilitation

The U.S. Fish and Wildlife Service, Michigan Department of Natural Resources, Ontario Ministry of Natural Resources, and the Chippewa Ottawa Resource Authority participates in the interagency effort to restore lake trout to self-sustaining levels in Lake Huron. Supplemental lake trout stocking in U.S. waters of Lake Huron is conducted primarily by the USFWS' National Fish Hatcheries. Fall spawning surveys at offshore reefs in the Six Fathom Bank and Yankee Reef complex monitor natural reproduction that occurs at those sites. The overall rehabilitation effort is tracked by analyzing data collected through interagency fishery assessment activities.

7.2.2.2 Lake Sturgeon Restoration

The U.S. Fish and Wildlife Service, in partnership with the Michigan Department of Natural Resources, has led an interagency effort in the Lake Huron – Lake Erie region of the Great Lakes to determine the status and trends of surviving lake sturgeon stocks. This effort has relied on cooperation from state, tribal and provincial commercial fishers to collect measurements and externally tag by-caught sturgeon, allowing the assessment of movement and distribution. Additional research includes the genetic analysis and profiling of spawning stocks from numerous Great Lakes tributaries, including one of largest known spawning sites in the St. Clair River.

7.2.2.3 Monitoring the Growth and Condition of Lake Whitefish

The National Oceanic and Atmospheric Administrations' (NOAA) Great Lakes Environmental Research Laboratory, in partnership with MDNR, USFWS, and OMNR, is examining the diet, condition, and growth of lake whitefish in various regions of the lake. These variables will be examined relative to abundances of the amphipod *Diporeia*. This important food organism is now declining and completely gone from many lake areas (see "The Lower Foodweb" below).

7.2.2.4 Managing the Lake Huron Treaty Fishery

Working with the Chippewa Ottawa Resource Authority, the Alpena Fisheries Resource Office (FRO) Treaty Fishery Unit fulfills Department of Interior and Service federal-tribal trust responsibilities by conducting activities in support of the Year 2000 Consent Decree, a 20 year fishery allocation for 1836 Treaty waters between the federal government, state of Michigan, and 5 Native American tribes. The Treaty Fishery Unit conducts fishery assessments in Lake Huron, annually performs statistical-catch-at-age modeling to determine safe harvest limits of lake trout and lake whitefish in 1836 Treaty waters, and provides technical assistance to tribal and state resource agencies.

7.2.2.5 Monitoring Fish Community Health

The U.S. Geologic Survey's Great Lakes Science Center conducts annual bottom trawl surveys at several locations in Lake Huron to determine the abundance, size and age structure of key prey species community composition, and prevalence of exotics. Fish collections are also sampled for analysis of contaminants, energy density, genetics, epizootics, and coded wire tags (lake trout). Fish community assessments are expanding, with hydroacoustic studies of the pelagic community beginning in 2004, and planned additional sampling of lower trophic levels in conjunction with fish surveys.

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6 7.2.3 Targeting the Saginaw Bay Aquatic Ecosystem

Saginaw Bay is one of the most biologically productive portions of the U.S. Lake Huron watershed. Several efforts are advancing the restoration of this critical region. Two are highlighted below.

7.2.3.1 Walleye Recovery in Saginaw Bay

In 2003, the MDNR Fisheries Division presented the Saginaw Bay Walleye Recovery Plan to stakeholders for their approval and endorsement. The Saginaw Bay Walleye Recovery Plan is a science-based blueprint for management actions intended to achieve a self-sustaining walleye population and restore ecological balance to the fish community. Biological benefits from the recovery plan are anticipated to extend to the greater fish community, including yellow perch. The recovery plan focuses on 1) reducing stream habitat and sediment delivery to the bay, through collaboration with partner agencies such as MDEQ and the Natural Resources Conservation Districts as well as stakeholder watershed groups, 2) achieving fish passage at key dams, 3) reef rehabilitation, and 4) increased stocking of fingerling walleye (to 2.8 million) to shift the predator/prey balance. This effort is closely linked to the effort described below.

7.2.3.2 Restoring Fish Passage to Saginaw Bay Tributaries

A pilot project is currently investigating how to restore natural flows and enhancing fish passage over low-head barrier dams in the Saginaw River watershed. A decision-making tool and strategy for resource managers and communities that will identify the most cost-effective options for dam removal/fish passage to achieve the targeted, sustainable fish population goals for Saginaw Bay. In cases where dam removal is unlikely in the near-term, a design feasibility study will identify techniques for enhancing fish passage over a barrier dams. This effort, organized by Public Sector Consultants, includes the following project partners: The Partnership for the Saginaw Bay Watershed, Michigan Department of Natural Resources, City of Frankenmuth, Michigan Department of Environmental Quality, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and community representatives. This project could provide a template for fish

passage on other Great Lakes tributaries.

7.2.4 Wildlife and Habitat Management

7.2.4.1 The Great Lakes Piping Plover

The USFWS and its partners continue to implement a program aimed at recovering the Piping Plover on federal, state and private lands. The U.S. Fish and Wildlife Service (USFWS) is estimating the total number of nesting Piping Plover pairs, eggs laid, eggs hatched and chicks fledged. This information will help determine cause of mortality of eggs, chicks, and/or adults, as well as implementing and evaluating protection/recovery strategies. Ultimately, the effort will lead to recommendations to improve nesting success, long-term plover population persistence, and population recovery. USFWS also partners with the State of Michigan to provide educational/information materials on coastal ecosystems and the rare, threatened or endangered species that inhabit them. The focus of the program will be on the protection the federally endangered piping plover and its nesting habitat on Michigan State Park lands through managing state lands during the nesting season and educational programs about the nesting piping plovers and the importance of coastal ecosystem processes.

7.2.5 Understanding the Lower Food Web

All fish species rely on the small organisms of the lower aquatic food web, especially during the first few years of growth. The small shrimp-like organism called Diporeia is an important food organism for Lake Trout and Whitefish. Data suggest that Diporeia now declining and completely gone from many lake areas. Scientists are investigating these changes, as described below.

7.2.5.1 Benthic Macroinvertebrate Community of the Open Waters of Lake Huron

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The Great Lakes Environmental Research Laboratory, NOAA, in partnership with OMNR and NWRI, are conducted a benthic macroinvertebrate survey in the main basin of Lake Huron in 2003 to determine trends in major macrobenthic groups. Many of the 80 sites sampled were also sampled in 2000. Of most interest are changes in abundances of the amphipod Diporeia and dreissenids (zebra and quagga) mussels.

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7.2.5.2 Changes in the Lower Food Web of Saginaw Bay

The Great Lakes Environmental Research Laboratory, NOAA conducted a large study in Saginaw Bay between 1990 and 1996 to assess the impact of the zebra mussel on the lower food web (nutrients, phytoplankton, zooplankton, benthos). While a portion of the data has been analyzed and published, present efforts will complete the analysis and provide an overall synthesis.

7.2.6 Monitoring the Threat of Invasive Species

The Eurasian Ruffe continues to be found around the Alpena area and has the potential to become a significant component of the fish community. The expansion of the range of this species has been closely monitored over the past decade. Since 1992, the U.S. Fish and Wildlife Service has conducted annual surveillance to monitor Aquatic Nuisance Species (ANS) and population trends of nearshore fish community at Lake Huron ports, river mouths, and in the St. Marys River. These efforts monitor the existing fish community, track the effects of the Eurasian Ruffe, and provide early warning of new ANS populations.

7.2.7 Community Planning Efforts

Communities are expanding their efforts to incorporate natural resource management efforts in their land-use planning and zoning laws. One recent effort is highlighted below.

7.2.7.1 The Misery Bay Initiative, A Plan to Protect Coastal Ecosystems


The Northeast Michigan Council of Governments, is helping Alpena-area governments establish protections for nearshore terrestrial ecosystems through a coordinated planning effort. The partnership, partially-funded through U.S. EPA- GLNPO's competitive grant program, includes governmental agencies, local government, land owners, industries, and conservation organizations. The process will include assessments of existing conditions, review of local planning and zoning, analysis of threats to ecological values, and development of strategies for resource protection. This project will continue through 2004.

7.2.8 Improving Data Management and Sharing

7.2.8.1 Lake Huron GIS

Agencies are continuing to investigate way to use technology to enhance management efforts. The Lake Huron "geographic information system" decision support tool developed by Michigan Department of Natural Resources has helped quantify connectivity issues, target habitats for restoration and protection, and build public support for management actions. Hundreds of spatial data layers have been integrated into the GIS system, including biological data (e.g., fish and bird data including invasive and threatened species); base layers (e.g., political boundaries, nautical charts, and management units); classifications for tributary, terrestrial, and wetland habitats; and environmental layers (e.g., areas affected by fish contaminants, areas of concern, locations of remedial action programs). Data layers have been structured to accommodate all levels of GIS users.

7.2.8.2 Bald Eagle Monitoring Database

Section 7  In cooperation with Michigan State University, USFWS personnel are now using the state-wide bald eagle database created by the University's Department of Fisheries and Wildlife. The USFWS serves as the primary clearing house for all bald eagle data records in the State of Michigan and the new database assists in ensuring accuracy and validity of existing and newly added data from around the State. The project provides the USFWS with additional organization and accuracy of bald eagle records and georeferencing assistance.

7.2.8.3 Improving Coastal Wetland Restoration through a Conservation Lands Inventory

Through U.S. FWS support, Ducks Unlimited and is creating a comprehensive GIS layer of Conservation And Recreation Lands (CARL) for the Lake Huron watershed (as part of a project spanning five of the Great Lakes States: Wisconsin, Michigan, Illinois, Indiana, and Ohio). The CARL GIS layer will consist of public lands (Federal, State, and locally owned lands), private lands (The Nature Conservancy, Audubon, and local conservancies) and conservation easements (Wetland Reserve Program, Conservation Reserve and Enhancement Program, etc.). By creating the CARL layer for the five Great Lake States with DU, the U. S. Fish and Wildlife Service provides a valuable tool for planning and development of coastal and inland wetland habitat restoration and protection activities. The CARL layer will also assist other land-use planners by formulating informed decisions, including plans for Greenways, conservation, and recreational activities.

7.2.8.4 Ranking System for Great Lakes Islands

Developed by the U.S. Fish and Wildlife Service, this tool uses a database and short narrative to rank islands to achieve conservation goals. The narrative include an executive summary, description of the methods, list of information sources, etc. The database ranks islands categorically by such variables as presence/absence of threatened & endangered species, nesting waterbirds, use by migrating passerines and other birds, presence of building structures, contaminants, fish habitat, etc. Other variables include

geographic location, vegetation type present, and land ownership. The database is searchable by lake, state, and by distance from other geographic features.

7.3 Long-Term Projects

As we look to the future, the year 2007 has been tentatively identified for the comprehensive monitoring and analysis of the health of Lake Huron. This year appears to work well for existing monitoring schedules, although much more work will be necessary to coordinate monitoring on this geographic scale. This topic will be on the future agenda of the Lake Huron Binational Partnership.

7.4 References

Blackie, M.M. and Tuininga, K.A., Prioritizing watersheds threatened by manure spills and manure mismanagement. Environment Canada, internal report. August 2003.